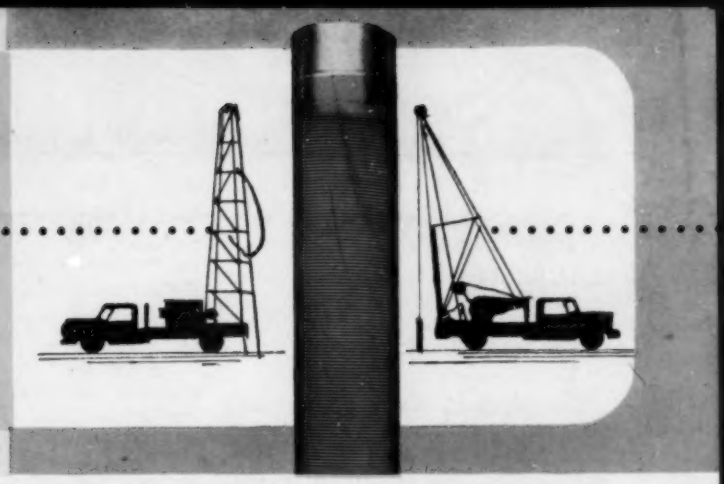
The Johnson National DRILLERS JOURNAL



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REASONS SOME WELLS ARE DISAPPOINTMENTS

(Continued from Nov.-Dec. issue)

This third article of the series on the subject of sand-pumping concludes the description and analysis of certain wells, constructed under varied conditions, that have given disappointing results from this cause.

Costly experiences with sand-pumping wells occur again and again where correct principles of well-design are ignored, and where makeshift substitutes are used in place of adequate well screens. During the summer of 1952, one of the biggest bills for pump repair we have ever heard of had to be shouldered by an irrigation farmer in Arizona. A short summary of what happened in this case shows just how costly sand-pumping can be.

The irrigation well is about 600 feet deep. It was drilled by the California mud-scow method and cased with 20-inch "stovepipe" casing. The casing was perforated at the depths where it was thought the best water-bearing sands were located. The turbine pump installed in this well has a capacity of more than 2,000 gpm, has 10-inch column pipe and is set 400 feet below ground surface. From this description, it can be seen that the well and pump represent a considerable investment. (If a proper well screen had been used in place of slotting the casing, the first-cost of the well would have been 10-15% more.)

The well, when completed, pumped sand. It was hoped, however, that the amount of sand would decrease as the well was used. Unfortunately, the sand kept coming.

During the 1952 irrigation season, the pump had to be pulled from this well six times for repair. The deadly cutting effect of the sand, pumped with the water, ruined one set of pump-bowls after another. Pulling and re-setting a pump like this, with 400 feet of column and shaft, is quite an operation in itself. Pump-bowl replacement and other repair work plus the cost of pulling and re-setting the pump amounted to over $2,000 for each of the six times the pump had to be fixed. The total bill for pump work during one season was more than $12,000.

This repair bill, almost unbelievable in amount, was equal to more than 50% of the first-cost of the well. Yet, an additional investment of 10-15% for a well screen that would have prevented the sand-pumping was thought to be "uneconomical" by both the driller and the well-owner.

Gravel Treatment vs. Development

Two good lessons can be learned from a fairly long-term experience with a gravel-packed well in the municipal well field at Eau Claire, Wisconsin. This progressive city has an excellent well field of eleven wells. Well No. 5 is artificially gravel-treated; the other nine wells are all naturally-developed. The history of well No. 5, compared with the others, shows that:

1. It is a false idea to depend on large diameter and great thickness of artificial gravel treatment to prevent sand pumping

Pictures taken of the operation of feeding gravel thru 8-inch feed-pipes while gravel-packing well No. 5 in the municipal well field at Eau Claire, Wisconsin. The tops of the gravel feed-pipes can be seen in each view.

rather than using a correctly-graded material.

2. Natural-development is a better method of well completion than artificial gravel treatment where the formation lends itself to development.

Development of the present well field at Eau Claire was started in 1932 by the construction and testing of a 12-inch test well, 98 feet deep, equipped with an Everdur well screen 30 feet long. This was a naturally-developed well and a remarkably good one. It pumped 1,990 gpm with a little less than 4 feet drawdown after being tested for 157 days.

Drilling of the first four permanent wells in the new field was started in 1934. Unfortunately, the excellent test well that had been put in was located where a road had to be built, so could not be used as a permanent well. The well screen was pulled out of this well, however, and re-installed in the first of the permanent wells some distance away. Three more wells were then drilled and a pumping station was built.

All these first four wells were naturally-developed. They were of different depths ranging from 75 feet for the shallowest to 95 feet for the deepest. The total capacity of these four wells was 7,090 gpm or 10 million gallons per day. The specific capacities (rate per foot of drawdown) of the individual wells were as follows:

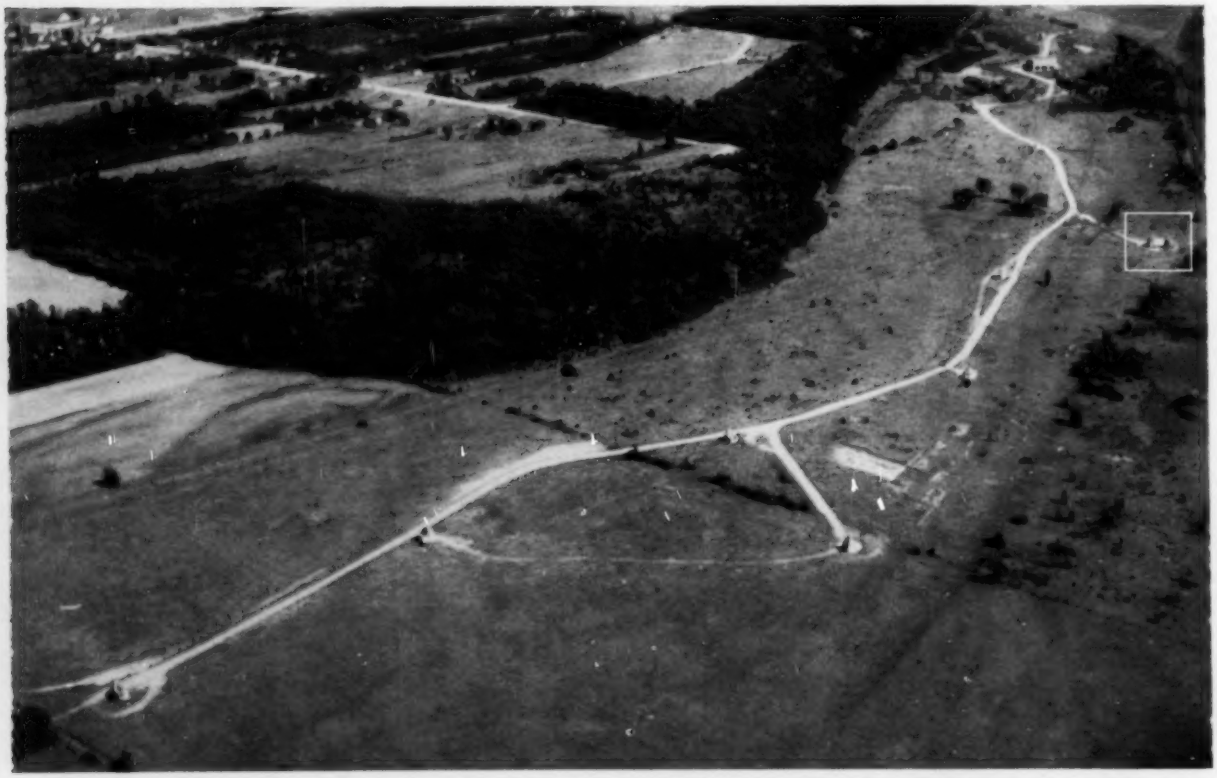
Well No. 1	140 gpm per ft. DD
Well No. 2	191 gpm per ft. DD
Well No. 3	116 gpm per ft. DD
Well No. 4	108 gpm per ft. DD

In 1938, during the third year of their operation, it was noted that these high-capacity wells were dropping off in yield. Investigation showed that the cause was the growth of slime-forming bacteria in the vicinity of each well. A means of treating the wells with chlorine to kill the bacteria was worked out and applied.

The treatment was highly effective and restored the capacity of the wells so they could be used at their original pumpage rates.* This method of treatment has been adopted as a routine annual maintenance operation at Eau Claire. All of the wells have been maintained at high capacity over the years by this systematic procedure.

Early in 1937, the well field was enlarged by the drilling of two more wells, No. 5 and No. 6. Three test holes in the vicinity of the desired location for well No. 5 showed that the water-bearing sand at this site was somewhat finer in grading than that encountered in the first four wells. This fact, plus a desire to compare a well of artificial gravel-pack design with the natu-

*See "Restoring Well Capacity With Chlorine" by E. D. Brown, Journal of the American Water Works Association, May, 1942.



Aerial view of the 11 wells in the municipal well field at Eau Claire, Wisconsin. Well No. 11 is at the lower left. The well circled in the picture is No. 5 and is the only gravel-packed well in the field; the others are naturally-developed. All wells are equipped with Johnson Well Screens and were drilled by Keys Well Drilling Company of St. Paul, Minnesota.

rally-developed wells, led to a decision to complete well No. 5 as a gravel-packed well.

The technique of calculating the correct size of gravel, based on the grading of the formation sand, had not been developed in those days to the point that it has today. Many people felt then that the grading of the gravel was not too important if a large enough quantity of gravel was put in around the screen. The theory was that if the artificial gravel-pack were made sufficiently large in diameter, the velocity of the water as it moved out of the natural formation and into the gravel zone would be low enough so that it would not carry with it any of the formation sand.

Based on this line of reasoning, it was decided to construct well No. 5 by setting the well screen in a 16-inch drilled hole and to feed gravel through 8-inch feed-pipes put down into the water-bearing sand about 10 feet from the well. The photographs on page 2 show the set-up on the job and the tops of some of the 8-inch feed-pipes. The slot openings in the well screen were large enough to let the formation sand come through as the well was pumped and bailed. As the material from around the screen was thus removed, it was hoped that an equal volume of gravel would move down through the feed-pipes and replace this sand.

Some difficulties were met in getting the gravel to move down as rapidly as the formation sand was removed through the well screen. However, after considerable work, the driller did succeed in pulling the gravel around the screen to the extent that he could no longer bring in any more sand. A total of 162 cubic yards of gravel was worked down around the well screen. It was felt that a large-diameter well had, in effect, been constructed.

Theoretically, it would have required a seven-foot diameter hole for the length of the well screen to hold the 162 cubic yards of gravel. This would make an artificial gravel-pack about three feet thick all around the well screen.

Upon completion, well No. 5 was test-pumped at rates up to 2,500 gpm. It had a specific capacity of 106 gpm per foot of drawdown at a yield of 2,120 gpm. This compared favorably with the yields of the first four wells; but not long after well No. 5 was placed in service, it was found that it was pumping some sand. The sand-pumping was, of course, a surprise to everyone concerned. Much confidence had been placed in the fact that the large quantity of gravel-packing around the screen would assure a sand-free well. But this experience, and other similar ones, point clearly to the basic principle of using the proper grading of gravel treatment in any gravel-packed well.

Well No. 5 at Eau Claire, artificially gravel-treated, being test-pumped after completion in 1937. The well is 95 feet deep. A total of 162 yards of gravel was used. The well pumped 2,500 gpm on test; but the rate must be kept down to 1,100 gpm in service to avoid sand-pumping.

Fortunately, it was found that by reducing the rate of pumpage on this well to about 1,100 gpm the amount of sand in the water was negligible. The well has been in use for a number of years now, pumping at this reduced rate.

The experience with gravel-packed well No. 5 proved to the water department that the best type of well construction for the well field at Eau Claire is the naturally-developed well. Wells number 6 to 11 have since been added to the well field. All these are naturally-developed wells and are of high capacity. The best of the group is No. 9, drilled in 1946, which was test-pumped at 1,930 gpm with 8.8 feet drawdown—a specific capacity of 219 gpm per foot of drawdown.

Sandstone Wells

Most of the water-bearing sandstone formations of the United States contain a cementing medium bonding the sand grains strongly enough so that wells can be completed in the sandstone as rock wells. A well screen is not usually required. The degree of cementing and the hardness of these formations do vary considerably, however. Sometimes the material is so weakly cemented that trouble from caving of the open hole does develop, resulting in sand pumping.

This difficulty is obviously not due to improper well design or site selection. It is simply a problem that comes up occasionally because of the inherent variations in the degree of cementation of the sandstone aquifer. Very often the formation stands up like rock when the well is new, but starts to cave slightly after the well has been pumped for a few years. When this happens, a well screen is needed and it must be designed and installed so that it will fit the special requirements of the situation.

The experience of the Utility Commission of Cumberland, Wisconsin, is an example of how the problem of sand-pumping of two wells in sandstone was solved by the proper use of well screens. The

screening of caving sandstone wells is one instance of well completion that almost always requires artificial gravel-packing.

The face of the drilled hole in the sandstone must be supported at every point. Since this face is irregular, to some extent at least, it is not possible for the well screen itself to conform to the exact shape of the hole. A gravel envelope around the screen must be used, therefore, and it must be carefully placed so that it is in intimate contact with every square inch of the wall of the hole.

The thickness of the gravel treatment is unimportant. In most cases, it should be as thin as possible, being limited only by the practical requirements of putting the material in place around the screen.

One of the wells in sandstone at Cumberland was drilled in 1943. In 1949, it was noticed that the well was pumping some sand. The Superintendent of Utilities discussed the problem with us and we recommended the use of a well screen to overcome the difficulty. The following is the log of the well:

Fill	0'— '
Sand and Gravel	6'— 30'
Sandy Clay	30'— 35'
Dirty Sand	35'— 75'
Hard pan and marl	75'—145'
Dirty sand-rock	145'—160'
Soft sand-rock	160'—205'
Hard sand-rock	205'—220'
Soft sand-rock	220'—230'
Firm sand-rock	230'—290'
Sand-rock and shale	290'—390'

This well is cased with 20-inch pipe to 160 feet and 12-inch pipe to 257 feet, grouted in. Originally, a 12-inch open hole was drilled from 257 feet to bottom at 390 feet. The static level was at 22 feet and, when first tested, the well yielded 490 gpm at 53½ feet drawdown.

The use of a small-diameter well screen artificially gravel-packed in the 12-inch open hole was recommended. After considering the practical aspects of placing the gravel treatment, it was decided that a six inch screen was the largest that could be used. With a six-inch screen centered in the 12-inch hole, the thickness of the gravel treatment was three inches. It was desired to screen most of the entire extent of the open hole and a screen length of 115 feet was decided upon, with a pipe extension at the top to lap inside the well casing above the 257-foot level.

The grading of the gravel treatment material was determined so that it would positively control the sand of the formation. Although we are referring to it as gravel treatment, the material actually selected was really a coarse filter sand and contained no particles as large as gravel. The smallest particles were 0.030-inch and the maximum size was 0.100 inch. Based on the grading of this material, No. 24 slot was selected for the size of screen openings.

In accordance with the design, a six-inch Everdur well screen, 115 feet long, with No. 24 slot openings was made up for the job. Centering devices were attached to the screen to hold it in the center of the 12-inch open hole. The screen was set in the hole and the filter sand was carefully placed around it. Backwashing and light surging inside the screen helped to break down any bridging of the material in the narrow space between the screen and the wall of the hole. Minor trouble from bridging did come to light later but was overcome by a special backwashing operation.

The 500 gpm turbine pump was re-installed in the well. Testing at various rates of pumpage for two or three days showed the well to be sand-free. Furthermore, the efficiency of the re-constructed well, with the well screen, is practically the same as when the well was new. At the present time, almost five years after the work described here was done, the well is delivering 500 gpm of sand-free water with a drawdown of a little less than 60 feet. The present specific capacity is about 8.5 gpm per foot of drawdown compared to the original 9.1 gpm per foot.

Increased water demand at Cumberland required a new well in 1950. A 24-inch hole was drilled that penetrated sandstone from 200 to 385 feet. The sandstone formation at this new location caved during drilling and a well screen had to be put in before the well could be used.

Fifty feet of 12-inch, No. 25-slot, Johnson Screen, made in six sections were used. These screens were spaced out over a 165-foot thickness of the formation. The well was sand-free when test pumped at 900 gpm. It is pumping 750 gpm in service with 60-feet drawdown.

There is practically no increase in drawdown in these sandstone wells from the use of screens. On the other hand, the correct application of well screens has made both of them usable and sand-free.

Testing aquifer at 310-foot level, Ellisbury Pumping Station of New Jersey Water Company. Well was completed at depth of 527 feet, using 35 feet of 10-inch Johnson Well Screen. Completed well pumped 1000 gpm with pumping level at 80 feet. Drilled by A. C. Schultes & Sons, Woodbury, New Jersey.

Recharge and Travel of Pollution

Important data on how a recharge or diffusion well operates has been published by the University of California in a progress report on "Investigation of Travel of Pollution." In order to pass on this information to those who want more knowledge about recharge wells, we are presenting here an abstract of parts of the report.

The investigation being made by Sanitary Engineering Research Projects* of the University is for the California Water Pollution Control Board. In some areas of California, practical means of recharging overpumped aquifers must be found or pumpage must be reduced soon. Salt water intrusion is damaging some aquifers now. Reduced yields in other places, where water levels are dropping seriously, will mean letting some irrigated lands go dry again.

The need for the investigation is the general lack of scientific knowledge of underground travel of pollution with ground water movement. The objectives of the work include:

1. The extent and rate of travel of pollution with ground water flow as determined by analyses of bacterial, organic and mineral matter.
2. The use of recharge, infiltration, or pressure wells as a means of waste water disposal and ground water replenishment.
3. The method of operating and maintaining recharge wells at sustained optimum injection rates.
4. The economic aspects of ground water recharge through wells.

The results of this investigation, and any future extensions of it, will doubtless have much bearing on whether or not California law will be amended to allow recharge with waters other than those fit for human consumption. Other localities that are faced with problems from ground-water depletion will be vitally interested in this project, as well as those who are interested primarily in the conclusions regarding the travel of disease-producing pollution.

The project involved the installation of one 12-inch recharge well, and 18 six-inch observation wells located at distances from 10 to 500 feet from the recharge well. All these wells were drilled through a confined aquifer of sand and pea gravel. The aquifer averages 3½ feet in thickness and lies between 90 and 100 feet below ground surface.

The north-south and east-west sections in Figure 1 show the position of the aquifer at some of the well locations. The casing in each well was perforated in the section extending through the aquifer.

The log of the recharge well is as follows. It is typical of the logs of all the others.

Clay	0′ — 5′
Brown sand	5′ — 9′
Sandy clay	9′ — 33′
Pea gravel & sand	33′ — 34′
Sandy clay	34′ — 38′
Fine sand & gravel	38′ — 42′
Sandy clay	42′ — 44′
Clay, some gravel	44′ — 73′
Pea gravel & sand	73′ — 75′
Blue clay	75′ — 94′
Pea gravel & sand	94′ — 100′
Sandy clay	100′ — 105′

The recharge well was fitted with a flange top to permit mounting a turbine pump. This pump was used to redevelop the well as needed by pumping out and clearing the formation around the perforated section whenever clogging occurred. Recharge water was put into the well through the turbine pump. Fittings were provided for measuring pressure and for bleeding air.

The observation wells were capped and provided with means for taking water samples and determining the head both when the water head was above ground level and below the surface.

The recharge well was developed initially by heavy pumping with

* Director of Sanitary Engineering Research Projects, University of California, is Harold B. Gotaas. Ray B. Krone is project engineer on this investigation.

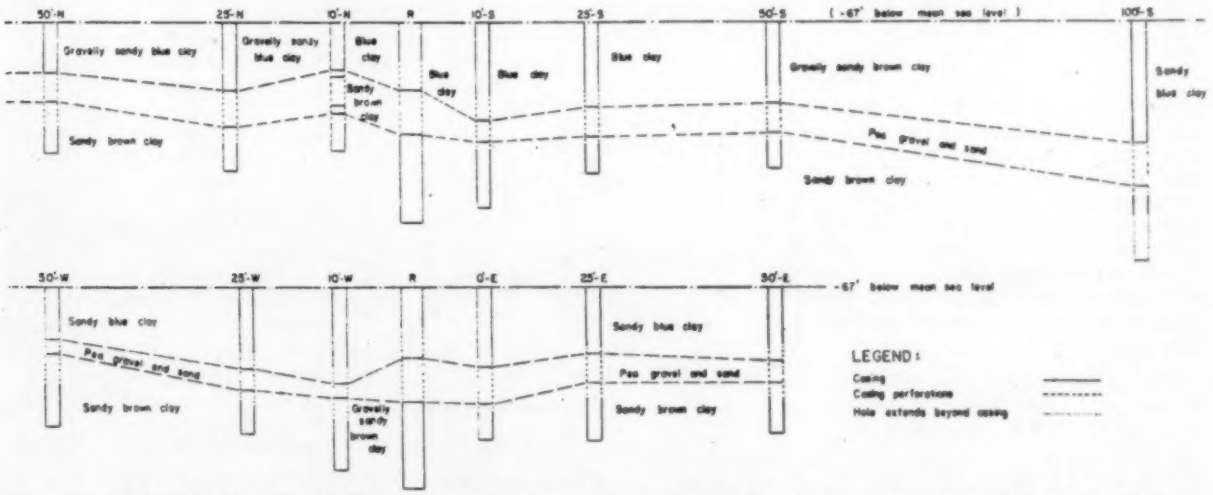


Figure 1. North-south and east-west sections thru 12-inch recharge well showing the aquifer that was recharged in the California investigation.

the turbine pump and at a later time by surging. The observation wells were developed until clear with a small jet pump.

The fresh water supply for recharging was obtained from two shallow wells tapping the water-bearing formation at 32-34 feet below ground. Tests were made to prove that there was no connection between this stratum and the deeper formations.

The aquifer to be recharged was first tested by pumping the recharge well. While pumping at 68.5 gpm, water-level readings were taken in the observation wells. Figure 2 shows the water levels and hydraulic gradients during this test. Note that the drawdown in the 12-inch pumped well was about 56 feet, making the specific capacity 1.2 gpm per foot of drawdown. From the pump test data, it was estimated that the safe yield of this well is about 92 gpm.

Injection of Fresh Water

Recharge operations were begun with fresh water. Injection was started on February 4, 1952 at a rate of 13.5 gpm. The water levels rose in all observation wells and equilibrium was reached after a while under this rate of recharge. Figure 4 shows the water levels and gradients. Note that the water level in the recharge well is about 15 feet above static level. (Specific capacity at this rate of recharge is 0.9 gpm per foot of head.)

On May 11, 1952 the rate of recharge was then increased to 16.6 gpm. Equilibrium at this rate was established in a few days.

On May 21, 1952 the rate was again increased to 31.6 gpm. Equilibrium conditions were reached in one week. This rate of injection was maintained with only minor interruptions until February 9, 1953, at which time injection of polluted water was commenced. While using fresh water, the rate of travel of the recharge water was determined by the use of fluorescein dye.

Figure 5 shows the gradient curves with the recharge rate at 31.6 gpm. It will be noticed that the head on all of the wells is now above ground level. The positive head on the recharge well is approximately 34 feet. The well pumped water at a rate of 68.5 gpm with a drawdown of 56 feet, or a yield of about 1.2 gpm per foot of drawdown. It took the recharge water at a rate of 31.6 gpm with 34 feet of positive head, or a recharge of about 0.9 gpm per foot of head —about 75% as much recharge as yield. This, of course, does not indicate the true rate of recharge over an extended period of time, but it is interesting in the light of the commonly accepted theory that a well will take about the same amount of water as it will yield.

While injecting fresh water at 13.5 gpm, a 1400-gallon slug of water containing 3000 ppm of salt and some fluorescein dye was put in the recharge well.* The first thing noticed was that the water level in the recharge well rose one foot and stayed at this higher level. Next, a sample of water taken at an observation well when the dye arrived showed a large increase in the magnesium content of the water and almost no increase in sodium. This means that there was base exchange between the sodium of the salt water and the magnesium of the clay in or above the aquifer. The sodium probably dispersed some of the clay around the well and this resulted in the increased pressure head.

Operations were stopped and the clay dispersed by the sodium was immediately pumped out by the redevelopment pump. Pumping was continued until dye could no longer be seen. Recharging was then resumed.

Another test of rate of water movement was made in September, 1952 while recharging at 31.6 gpm. Only dye was used this time. A 450-gallon slug of water containing 100 ppm of fluorescein was injected and samples taken at 5-minute intervals at the nearest observation wells.

By comparing the times of arrival of the dye in all the wells, it was seen that the movement was more rapid to the south and east. This was the direction of the normal ground-water movement. The static level, before the test started, sloped one foot per 1000 from north to south.

This excellent research work was rather badly interrupted and disturbed at two points due to well troubles. The wells which furnished the fresh water supply failed and had to be repaired due to sand clogging the perforated casing. The recharge well also failed toward the latter part of the test due to sand-pumping through the perforations, which produced a

*See "Methods of Tracing Ground-Water Flow," Johnson National Drillers Journal, Sept.-Oct., 1953.

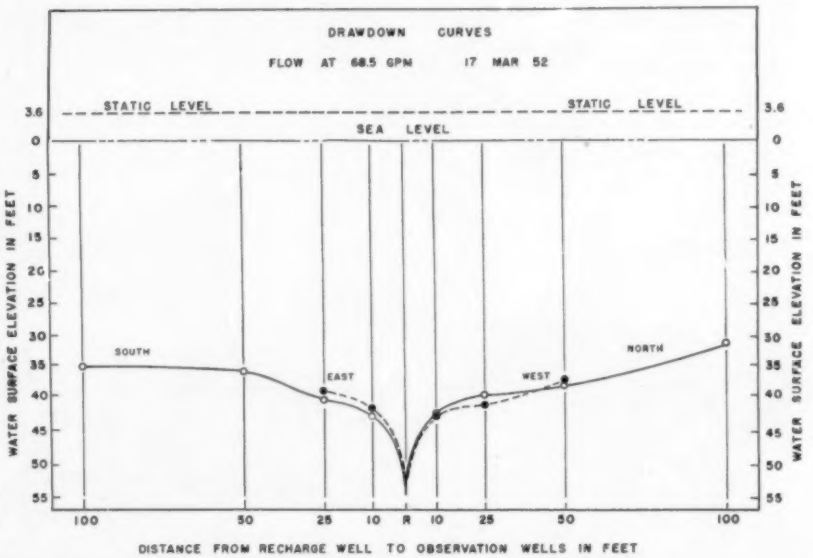


Figure 2. Cone of depression developed when 12-inch recharge well was pumped at 68.5 gpm. Solid line represents north-south water levels; broken line represents east-west water levels.

Figure 3. Observation well head with connections for pressure measuring device and outlet for taking water samples.

cave-in and connected the 75-foot aquifer with the recharge aquifer at 90 feet. In spite of these difficulties, the first portion of this project was brought to a successful conclusion and preparations were made for further studies later on.

Although recharge at the rate of 31.6 gpm may seem low, it must be remembered that the aquifer here is only 3½-feet thick. At this rate, the aquifer took 13,000 gallons per day for each foot of thickness. A 100-foot aquifer at the same rate of recharge would take 1.3 million gallons per day or 900 gpm.

Of particular interest were the general indications with reference to clogging. The commonly accepted causes of clogging are silt, clay and organic material carried in suspension in polluted water, and the presence of iron in one form or another. Less commonly recognized is the clogging that may result from clay dispersion in the aquifer itself caused by recharging with a fresh water of somewhat different chemical character than that of the existing water in the aquifer. The effect of the salt injection described shows how this can happen.

Clogging from suspended solids was very evident during recharge with polluted water in the tests following the work with clear, fresh water. The suspended solids content in the polluted water was only 3.3 parts per million; but the pressure in the recharge well rose about 30% in 9 days due to clogging. This indicates the necessity to provide for effective and frequent redevelopment when water carrying solids is recharged. Fortunately, it was demonstrated that the clogging occurred in the zone very close to the well. Adequate redevelopment to clean the recharge well could probably be quite effective if the well were equipped with a suitable well screen and properly stabilized.

Among the important observations made from the work described in this report are the following:

1. Recharge with clear, fresh water is possible at appreciable rates for long periods of time without clogging the aquifer.

2. Pollution travels farthest in the direction of ground water movement.

3. Bacterial pollution does not travel as fast nor as far as chemical pollution.

4. Clogging of the recharge well requires special consideration in design and operation.

5. If the recharge formation has a significant content of dispersible

(Continued on Page 15)

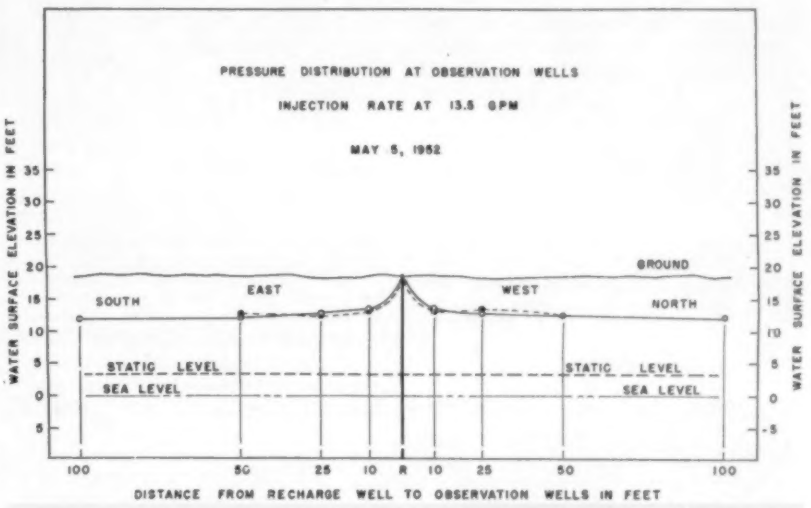


Figure 4. Ground-water curves developed while recharging aquifer with fresh water at the rate of 13.5 gpm.

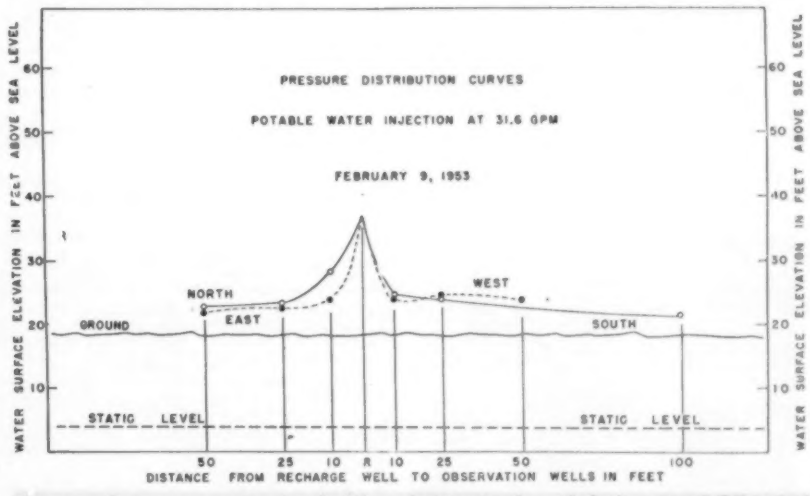


Figure 5. Pressure curves developed while recharging aquifer with fresh water at the rate of 31.6 gpm. Water levels at all points above ground in this test.

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TOM'S COLUMN

Dear Fellows:

Well, here's th' start of another year. Like all the other years, we kind of look ahead an' wonder what it's goin' to bring—an' like all th' others, it probably will have a mixture o' good an' bad things that we never expected. So th' best thing to do is just go right ahead an' not pay too much attention to all th' talk you hear. If you're running a business like well drillin', I think you're better off just doin' as good a job as you can as you go along an' not try to play the long shots.

One thing, though, that it makes good sense to take a good look at 'round this time o' year, is collections. After all, that's th' hay that keeps th' mare a-goin'. There's been lots o' businesses crippled by lettin' collections slip by. There ain't any of us that can afford to let our accounts go too slow on us. It's always harder to get 'em after they get old. It's too much like payin' for dead horses, an' people are likely to stall more an' more as time goes by. Then, first thing we know, we're short o' cash on hand; an' we either have to let our bills slide or go borrow money. That ain't good—neither one of them. Supply houses may not be hard up fer jest what we owe them, but our account is only one of hundreds or maybe thousands they have to keep comin'. An' when you have to borrow to pay your bills when you've got money comin' from your customers, you're jest paying out good money to carry them accounts on your books. Better spend some money by takin' the time an' expense of doin' th' collectin' before it goes any farther. That's a lesson I learned th' hard way long ago. I ain't hard-boiled about it; but I do go right out after what I got comin' an' if they ain't got a **good reason**—not jest excuses—I get th' money or I

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Montana

K. D. Thompson, President.....Wibaux
Bert Van Dyken, Sec'y-Treas.....Bozeman

Nebraska

Fred D. Salmon, President.....Concord
V. H. Dreeszen, Secretary.....Lincoln

Nevada

S. R. McKinney, President.....Las Vegas
William Wright, Vice-President.....Dyer

New Brunswick

Arthur LeBlanc, President.....St. Anselme

New England

Stanley Hillock, President.....Gorham, Maine
Ralph L. Gray, Sec'y.....Southville, Mass.

New Jersey

Fred Bock, President.....Rochelle Park
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James Stoutenberg, President.....Glenford
Clarence W. Crandall, Sec'y-Treas.....Pine City

North Carolina

P. Y. Bainbridge, President.....Guilford
R. O. Hester, Secretary.....Raleigh

North Dakota

Fred J. Simpson, President.....Bisbee
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Northwest

M. West, President.....Salem, Oregon
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R. D. Sawyer, President.....Chickasha
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C. D. McLean, Sec'y-Treas.....Ottawa

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R. F. Sneed, President.....Salem
O. E. Jannsen, Sec'y-Treas.....Clackamas

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E. D. Potter, Executive President.....North Wales

Eastern Division
Fank Parente, President.....Norristown
W. R. Raab, Secretary.....Churchville

Western Division
C. J. Markel, President.....Jeanette
Mrs. Muriel Butcher, Secretary.....Washington

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D. O. Hamilton, President.....Portsmouth
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South Dakota

Ben. J. Schrag, President.....Freeman
Harold Norbeck, Secretary.....Redfield

Tennessee

J. E. Miller, President.....LaVergne
E. S. Eatherly, Secy-Treas.....Lebanon

Texas

L. W. Capps, President.....Houston
F. L. Protzman, Secretary.....Houston

Virginia

Justus A. Ange, President.....Fairfax
C. R. Sundquist, Secy.-Treas.....Norfolk

Washington

Harold O. Meyer, President.....Kirkland
George L. Zent, Sec'y-Treas.....Vancouver

Wisconsin

Elsmer V. Sperling, President.....Iron Ridge
Ralph H. Nienow, Sec'y-Counsel.....Merrill

lower the boom. You know, a customer who don't pay you ain't a customer at all—he's jest a free boarder at your house.

Well, I really had somethin' else up my sleeve this time an' I'll come back off th' sidetrack now. This story takes me back to a job we done a while ago. I was reminded of it when my son an' I were goin' over th' specs on a job the other day. It was one o' them jobs where they had made up a nice, fancy set o' specs that had only one thing wrong with 'em—they didn't know what they was talkin' about. No, I ain't sayin' that to be funny. I mean jest that—they didn't know what they was talkin' about. They wrote all th' specs before they knew what conditions they was goin' up against.

Yes, sir, when you bid on that job everything was all set. You was to bid so much fer each set-up an' so much a foot for drillin' whatever test wells they decided to put down, an' so much fer test pumpin' etc.; but they had all th' details figgered out ahead of time. Th' well was to be 20-inch with a 12-inch screen and an inside line o' 12-inch pipe, to be gravel-packed with pea-size gravel (whatever that is). The pump was to deliver 500 gpm when the water head was a certain level in their standpipe. Might not of been so bad if this had not been in a place where well conditions was spotty, an' not far from there in two directions th' granite out-cropped. Th' well they had was some help in makin' their guess; but it wouldn't give anywhere near that much water an' they didn't have any real basis for knowin' that there was a good spot fer a well nearby. They simply decided that a 20-inch gravel-packed well ought to give 'em so much more water than their old well, and they was all set to go.

Now between you an' me an' th' fencepost, this was a job we heard about jest a few days before bidding time, an' we didn't have much time to go over it—not enough to try to get th' specs changed. There weren't many bidders—an' it soon come down to a dog-fight between one other outfit and us. This other driller had a good salesman on th' job, an' I reckon he done a first-class job of tellin 'em how he planned to get th' water. When my turn come an' I was asked how I planned to get that much water, I just told 'em I'd follow th' specs an' put down test wells wherever they wanted me to. Then when we found a likely spot we'd put down a darned good well that would give 'em all th' water th' formation could furnish. I told 'em that I didn't reckon that either the other outfit or us were any Moses that could whack th' rocks with a stick an' make them give water. That bein' th' case, we'd better settle fer what th' good Lord had put down there an' go after it with a good well.

I don't know how my sales talk got across; but we had a little price advantage to go along with it, an' we ended up with a job we hadn't really expected to get. Then th' fun started.

They had a special meetin' where they brought in an engineer from a nearby town who was goin' to take care o' their new combination pump-house an' firebarn an' do some surveyin' and other odds and ends. They should have had him before instead of afterwards. He said he didn't know much about wells but he had good common sense an' set out to find out what he could about it. We were all together at this meeting an' after five minutes o' chatter he asked th' first good sensible question.

"What makes you so sure you'll get a good well where you've planned to put the pumphouse and firebarn? Don't you want to make sure first, an' then draw up your plans?"

Well, there was a lot o' talk back an' forth an' it all simmered down to this: Somebody had purty well convinced th' council that on th' basis o' what the old well did, they could get what they wanted over at th' next corner where they wanted to put th' new building. Anyway, they had th' cart in front of th' horse all th' way through an' they did decide to unhitch him an' start all over. First thing they did was have th' engineer an' one o' the councilmen go with me over th' ground an' pick out some spots to start drillin' some test holes. We was to start by getting complete dope on th' old well. Then the test holes was to be done in th' order of th' most convenience — that is, th' first one where they had planned on; the second one over in

the next block where they could still build a new combination pump-house and firebarn. Th' next one over a couple of blocks further north where they could get some land, an' another one about six blocks further west and north. Then they was to try where it looked better to th' engineer an' me but not near so convenient — over on th' other end o' town where there was a flat stretch that reached out to th' east an' south to th' country where there was a

V. M. Newton of Gainesville, Missouri, drilling 6-inch well on a site for a suburban home.

(Continued from Page 9)

big old slough 'bout three miles out that was quite a duck hunter's spot. Trouble here was that it was away from the main part o' town an' at the tail-end of th' system.

Anyway, we started out. Th' old city well was being pumped at 200 gpm at the start o' pumpin' but when we checked it real careful we found she kept drawing down an' th' pump gave less an' less water. This should of been enough to make this whole area nearby look bad. Here's th' dope we got on the old well:

Drilled in 1927

Diameter: 8-inch

Total Depth: 67 feet

Static water level: 18 feet

Screened in sand and gravel between 52 ft. and 67 ft. with a Johnson 30-slot screen. Screen pulled out in 1938 and replaced with a Johnson 60-slot screen. Tested at 250 gpm for 8 hours after putting in the new screen.

Drawdown at end of pump test: 19 feet

That's what there was in th' records on th' old well. Now that doesn't really tell much of anything when it comes to figgering what you can do when you need more water. About all you could say is that it wasn't a bad or a good well—just sort of O. K.

We got the following new dope from the test we ran:

Static water level: 19′ 6″

Pumped at constant rate of 125 — 130 gpm from 8:00 a.m. Tuesday to 8:00 a.m. Wednesday. Drawdown readings taken with tape-line at 5-minute intervals for first hour; at 10-minute intervals for next hour; at 30-minute intervals for balance of test.

You'll notice from this that we held a steady rate of pumpin' and checked our drawdown real careful instead of pumping at a varying rate for so many hours an' measuring th' gpm an' th' drawdown at the end of th' test. My son an' th' engineer got together on this with th' Johnson people, an' this way they say they can come up with a better picture o' what a good well in a water-bearing formation can do at a higher or lower rate o' pumpin' over so many hours a day, day in an' day out. To finish th' test off we stopped th' pump an' measured th' rise in water level real careful at regular short spaces o' time from 8:00 a.m. until noon. By that time th' storage was 'bout gone an' we had to get th' pump back on th' line. To help in th' test th' village council had put on an order to hold down on th' use of water, otherwise we couldn't of run this long.

Anyhow, th' upshot of th' whole thing was that th' old well was doin' jest about all she was good for, and any well near to it probably would run into a lot of interference with it. We went ahead anyway, an' put down th' first test well where they had wanted th' new well. Here was our log:

Formation	Depth
Soil	0′ — 3′
Sandy clay	3′ — 17′
Fine sand (water)	17′ — 22′
Coarse sand	22′ — 29′
Sand & gravel	29′ — 61′
Granite	61′ — 64′
Static water level	17′

The static water level was actually th' same as in th' old well — there was jest about this difference in the grade level. Now, fer all practical purposes th' two locations were th' same, except th' new location was a little shallower an' so not likely to be quite so good. We run a pumpin' test—in fact two—one straight pumpin' fer 24 hours an' th' other at a fixed rate fer 24 hours. Th' other well was shut down during these tests. We finished the test well with a 60 slot 10-foot Johnson steel screen from 51′ to 61′, an' gave it a good develop in' job. By th' way, it was a 6-inch well.

Here was th' straight pumpin' test — 250 gpm with 26 foot drawdown. After making allowance fer size and screen length, this was practically a standoff with th' old well. Th' other test gave th' same results. Then we ran a third test with both wells pumpin' fer 6 hours an' checked th' interference between 'em. Th' boys came up with a figure of about 20% interference between 'em. Anyway, this wasn't th' place fer th' new well. When we got through everybody agreed on this, so we went on to the next location. It was like lookin' fer a needle in a haystack.

We drilled th' next three wells where they was planned, an' each one got a little poorer than th' one before. It was easy to explain this because we were moving in the general direction of where the granite outcropped. So our next move was to go the other way. Th' first test over there was a dud. Th' second one looked a little better. We run two offsets from this one an' got a better idea of th' slope of th' granite when all th' dope we had was put on paper an' some section drawings made. That led us to th' next site an' we come up with a lot better deal. Here's th' log of No. 8:

Formation	Depth
Soil	0′ — 5′
Sand	5′ — 19′
Sandy clay (some water)	19′ — 27′
Sand with clay streaks	27′ — 36′
Clean sand, some gravel	36′ — 41′
Clean coarse sand & gravel	41′ — 57′
Broken granite	57′ — 61′
Solid granite	61′ — 63′
Static water level	18′

We screened an' tested this well an' found it was a better well than any of the others includin' their old well. Then it was agreed we were to put in two more test wells 100 feet from this one with each one 45 degrees off a line to the east. We pulled th' screen but left th' casin' in this No. 8 well an' were goin' to use it as an observation well. Th' next well which was to the northeast was a bit shallower — otherwise it tested out purty much the same. Number 10 to the southeast was almost identical with No. 8. When we tested it an' checked th' levels in No. 8 and No. 9 an' the boys went over all th' dope with th' Johnson people, we all agreed this was the spot to put down th' well. We didn't want to move out any further than we had to; an' so there wasn't much point to any more test wells. Th' estimate after the tests showed we should get a well good fer 500 gpm, pumping up to 8 or 10 hours out of each day, without any gradual

draining of this formation. This is what they wanted fer two big reasons — to satisfy a new industry that was planning to come in, an' to improve their fire rating.

We put in the well, an' here's what darn near made me cry. We had beautiful natural stuff in this formation. It needed to be gravel-packed just like I need a monkey's tail. In fact, it would do harm instead of good to try to gravel-pack it. But we had to go ahead an' go through th' motions of gravel-packing. Had to put down a 20-inch outside casing an' then a 12-inch line inside. We set a 12-inch 15-foot No. 100 slot Johnson Everdur screen with a 5-foot extension of 8-inch pipe on top an' pulled back the 12-inch casing. Then we put in some "pea-size" gravel between th' two casings an' went ahead and developed th' well. Of course, none o' that gravel-pack stuff ever got around th' screen. It was like painting a lily—you couldn't improve on it! It was jest put there to meet th' specs. Th' well was tested at 500 gpm which we held steady an' checked th' drawdown in this well and in th' test well No. 8. At th' end of 12 hours o' pumpin' th' drawdown was 15' 6".

This was a good well and a lot better than they could of got at the place they planned to use. They could jest as well have had a still better well without much more cost by making it a 20-inch all th' way; or jest as good a well fer less money by making it a straight 12-inch.

Now, there ain't anything unusual 'bout this whole story that most o' you fellers haven't run into in one way or another if you've been doin' much drillin' in the areas where conditions vary, like in th' glacial drift. But th' chief point I see is that there ain't any single answer to ev'ry well job; so in a case like this it's plain foolish to say jest what kind of a well should be put in until all th' information is there to start with. Do th' prospecting first an' then write th' specs fer th' best kind o' well—not the other way around, as happens ev'ry once in a while.

Them's my sentiments.

TOM

Hard hat made of fiber-glass reinforced plastic is strong, yet light and comfortable.

HARD HATS

. . . . for sensible heads

A severe head injury suffered by a prominent well-drilling contractor in Minnesota prompts us to say a few words about a practical safety measure that is much neglected by water-well drillers. Drillers ought to wear "hard hats."

Our good friend was on the job with one of his own machines last summer. Without warning, a crown sheave fell out of the mast and hit him in the head. With his skull split, he was taken to a hospital with little expectation that he would live. Luckily, he pulled through, but he is minus a good-sized piece of his cranium and had to have a metal plate set in to replace the chunk of bone that the surgeon removed.

Another experience we heard of recently turned out differently. Last spring, a power line-man in northern Minnesota was standing on the ground tying a wire on a straight line. Another line-man on a 40-foot pole nearby was getting ready to pull up slack in a wire. He had a 7½-pound wire grip on a hook on his belt (which came off) as he was getting into working position. The grip fell 32 feet, hitting the man standing on the ground on the head.

Fortunately, the line-man on the ground was wearing a fiber-glass hard hat. The hat saved him from serious injury, or possible death. His only injury was a one-inch cut, not even requiring a bandage. Damage to the hat consisted of a half-circle hole an inch across and a crack on the top rib.

In another case, an 8-foot piece of 4" x 6" timber fell 25 feet hitting a man squarely on top of his aluminum hard hat. The blow dented the hat, but the man escaped injury.

Things do fall from overhead around drilling rigs. It seems to be common sense to say that every water well driller ought to wear a hard hat when on the job. Just one accident is a dear lesson.

There are a number of different types and styles of these hard hats, depending on what the individual needs or wants. There are hats made from special aircraft-grade aluminum, hats made from fiber-glass and resin, hats made from plastics — hats to avoid head injuries; and special hats that don't conduct electricity, so that even if you bump your head into a high-tension wire, you'll never know it. They have accessories, so that you can be warm in winter, and they reflect the sun so that you keep cool in summer.

Among the companies who make these hats are the following:

Mine Safety Appliances Company
201 North Braddock Avenue
Pittsburgh 8, Pennsylvania

E. D. Bullard Company
275 Eighth Street
San Francisco 3, California

Both of these companies have distributors in all principal cities. If this story makes sense to you, and you are interested in finding out about hard hats, you can write them. Our advice is: Have a hard hat for yourself and each of your men — and everybody wear them!

"Things do fall around drilling machines."

ASSOCIATION NEWS

This section is devoted to the exclusive use of water well drillers' associations, both state and local. Notices, announcements, changes of officers and other items should be sent to The Editor, Johnson National Drillers' Journal, 2304 Long Ave., St. Paul 14, Minnesota.

COLORADO

Plans have been made by the Colorado Water Well Contractors' Association for a mid-year meeting the first week in June. The meeting will be at Pueblo and will include a tour of the Colorado Fuel and Iron steel mill. The 1954 annual convention will be held in Denver some time in November.

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WISCONSIN

The program is all organized and the finishing touches are being put on the arrangements for the meeting of the Wisconsin Well Drillers, Inc., at the Hotel Northland, Green Bay, on April 1, 2 and 3. This promises to be the best convention yet. Green Bay is a good location and past meetings there have always been well attended. Every Wisconsin drilling contractor should attend.

—o—

NORTH CAROLINA

The eighth annual meeting of the North Carolina Well Drillers' Association, newly re-organized in September, was held on November 21 in Winston-Salem. The officers selected at the preliminary meeting in September were confirmed for the coming year.

Membership requirements were set up at the meeting. Six years of experience in well drilling, including three years as a contractor, is the minimum for full members. Drillers with less experience may be associate members but without a right to vote. The board of directors must approve each member.

The association plans a one-day seminar to discuss well drilling and drilling contractors' problems as the main event of each annual meeting.

The next annual meeting will be held at a central location in the state in September, 1954.

New directors named include C. M. Hudson of Durham, H. C. Huffman and Ray Morrison of Hickory, and G. T. Shipman of Penrose.

SOUTH DAKOTA

The 1954 convention of the South Dakota Well Drillers Association will be held March 5 and 6 at the St. Charles Hotel in Pierre.

Governor Sigurd Anderson will head a distinguished and interesting group of speakers. Governor Anderson will speak on the proposed revision of state water laws.

All drillers, manufacturers and jobbers of well supplies are urged to attend this meeting. It will be highly informative and there will be a good time for all. Any questions on arrangements should be sent to Secretary Harold Norbeck at Redfield.

—o—

MINNESOTA

The Minnesota Water Well Contractors Association will hold its 32nd annual convention on March 25, 26 and 27 at the Hotel Nicollet in Minneapolis. There will be three days, chock-full of interesting exhibits and discussions. Speakers will talk about business conditions in 1954, geology of Minnesota, fishing tools, acids, tool bit and drilling problems, how to sell larger capacity wells, rotary drilling with cable tool rigs, electrical hazards, and maintenance of equipment. This promises to be one of the biggest and best conventions that Minnesota has ever had, and all Northwest drillers are urged to attend. Bring your drillers and helpers, too — it'll help them to get an overall picture of the industry, and see where they fit in the business.

Minneapolis is readying itself to greet the drillers, putting its best foot forward, so let's all be there!

—o—

INDIANA

The Indiana Association will hold its annual meeting in Indianapolis, at the Hotel Severin, on February 25 and 26. The early date was picked so that more drillers could attend, during the part of the year when things are normally slower. The hotel's fine accommodations, both for individuals and group meetings, will make for an enjoyable and profitable convention. Get your reservations in on time, so that all the drillers can be accommodated in the Severin.

Details of arrangements are being handled by H. K. Carr, Greentown.

OREGON

The Oregon Drilling Association, Inc. held its annual meeting on November 13 and 14. The follow-Inc. held its annual meeting on R. F. Sneed, president, Salem; Wm. Stennett, vice-president, Oregon City; and O. E. Jannsen, secretary-treasurer, Clackamas.

The program was interesting and instructive, with emphasis on water conservation, which is quite important in Oregon, and proposed legislation concerning conservation. The possibility of a registration or licensing law for well drillers was discussed at some length. A committee was appointed to explore the possibilities of getting a more beneficial lien law passed to aid well drillers.

The association is particularly proud of the fact that its membership increased 60% over the previous year. This is gratifying to everyone connected with the association, and is an indication that the organization is of real value to its members. We offer our heartiest congratulations to Oregon drillers on this outstanding accomplishment, and wish them an even more successful year in 1954. In addition, a health and accident insurance plan was inaugurated, which should produce considerable benefits to the membership.

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WASHINGTON

As reported in the last issue, the annual convention of the Washington State Well Drillers Association was held in Seattle on November 13 and 14. One of the main topics of discussion was a medium of advertising for the local driller. The Association decided to publish an illustrated pamphlet. This is to be purchased by the members and distributed throughout the area in which each works. The drillers realize they must "sell" their work to the community. The purpose of the pamphlet will be to inform the potential customer of the services he can expect from a driller.

Group insurance for the drilling contractor was thoroughly discussed. Policies regarding both health and accident and liability and property damage were explained. President Meyer, J. C. Maxwell and Ernest Axelsen, who

comprise the insurance committee, will now gather information on the type of coverage the group wants. The committee will then work with insurance companies to get the facts on policies available. This information will be presented at the Spring regional meeting to be held in Vancouver in March.

Two new directors were elected. They are L. R. Gaudio of Tacoma and W. B. Henderson of Ellensberg. At a meeting of the Board the following officers were re-elected: Harold O. Meyer, president; Al G. Kounkel, vice-president; and George L. Zent, secretary-treasurer.

MICHIGAN

Advance notice has come of the Michigan Well Drillers' Convention. This 26th annual convention will be held on Thursday and Friday, April 29th and 30th, at the U. S. Armory Building in Lansing, Michigan. Many of the most successful conventions have been held in Lansing and the Association is pleased that the meetings can again be held in the Armory there. Further information regarding the meetings will be in the next issue of the Journal. Inquiries about the convention should be addressed to Owen Corsaut, Jr., 32170 Lahser Road, Birmingham.

NEBRASKA

The 1954 Conference and Short Course of the Nebraska Well Drillers Association will be held at the University of Nebraska on February 18 and 19. The meeting will feature talks and discussions on engineering and hydraulic principles of irrigation-well construction, evaluation of test-drilling information, methods of installing and removing well screens, new developments on insurance of truck-mounted drilling equipment, progress of improvements in sanitary well installations, welding demonstration, pumps and pumping equipment, reverse-circulation well-drilling movie and other subjects. Plans for a late summer or fall picnic and a well-drilling demonstration will be discussed. The logs of about 2,600 test holes, compiled as a part of the ground-water program of the Conservation and Survey Division, University of Nebraska, and the United States Geological Survey, will be issued to the members. These logs are grouped by counties.

The manufacturers and jobbers will provide a Dutch Lunch and entertainment for the drillers on the evening of February 18. About 150 well drillers from all parts of the state are expected to attend.

(Continued on Page 15)

Above: Well No. 7 of The Amalgamated Sugar Company at Nampa, Idaho, flowing as shown before surging and cleaning. Well is 701-feet deep, gravel-packed, with 69 feet of 10-inch, No. 40-slot Johnson Well Screen. Completed well pumped 1625 gpm at 100-feet drawdown.

Right: Setting first section of 45-foot, 15" OD Everdur well screen in Well No. 9 of the Amalgamated Sugar Company. Well is 524 feet deep. Wells 7 and 9 both drilled by A. A. Durand & Son, Walla Walla, Washington.

Below: Pumping well No. 9 at sugar refinery of The Amalgamated Sugar Company at Nampa, Idaho. On final test, yield was 1,240 gpm sand-free at 84½ feet drawdown. This was the maximum capacity of the pump used. This well is capable of delivering more than 2,000 gpm.

ADVERTISEMENTS

We will insert advertisements for drilling equipment wanted or for sale, help or work wanted, etc., for our readers, free of charge. Advertisements must be brief, and we cannot assume responsibility for them, but will be glad to put parties in touch with each other by this means and suggest that they investigate any offers or inquiries carefully for themselves.

FOR SALE: No. 16 Ideco drilling machine in good condition. Mounted on a good truck and priced to sell. Write or call Eldon Bonnicksen, Estherville, Iowa.

FOR SALE: New 5⅝" casing; new 6" pipe; used pipe and casing. Write for new price list. Thomas H. Scheuren, 933 Fern Avenue, Reading, Pennsylvania. Telephone 41287.

FOR SALE: All steel Howell #60 rig with Bucyrus-Erie derrick and shock absorber; mounted on 1942 Chevrolet, good tires and motor. Price $1200. Spitzer Well Company, Marshall, or Tracy, Minnesota.

FOR SALE: Going out of business. Armstrong band-wheel drilling machine, semi-truck mounted; 4 cylinder I.H.C. power plant. Tools include: 3 bars, 4 x 18, 3½ x 12, and 3½ x 18; one 2½ x 27 string of tools, new; two sets of 4-inch jars; slip socket; 10", 8", 7", and 6" bits; bumper bar. Will sell all or part. See at Iowa Falls, Iowa, 609 Dale Dr.; or write Glen W. Smith, 1341 E. Villa Street, Pasadena 4, California.

WANTED: Need experienced, sober, well driller, age 30 to 60; good wages, steady work. Stewart Bros., P. O. Box 976, Schenectady, New York. Phone 6-2029.

FOR SALE: One No. 55 Speed Star drill with 33-foot telescoping derrick (in operation every day); mounted on 1½-ton, 1936 Chevrolet truck. Some tools. Mostly 2" and 3" wells. Ford pickup, 1945 model. Also 6-room house and 6 lots in fast-developing area on west coast of Florida. All for $9500. Reason for selling, other business. J. W. Cooper, P. O. Box 101, Freeport, Florida.

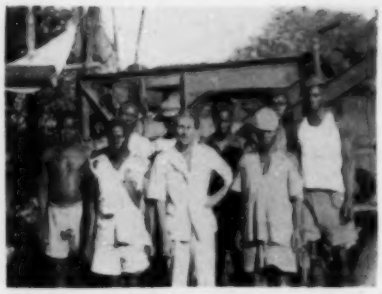
WANTED: Irrigation well drilling machine or component parts; also test-hole drill of smaller type. Ulysses Electric Implement, Ulysses, Nebraska.

FOR SALE: One Fort Worth spudder and tools, Model L, with International truck. P. O. Box 342, Prosser, Washington.

FOR SALE: No. 60 Keystone and No. 50 Keystone drills, with or without tools. Will sell mounted or unmounted. Box PT, c/o Edward E. Johnson, Inc., 2304 Long Avenue, St. Paul 14, Minnesota.

WANTED TO BUY: Either Keystone Model 26-K or Bucyrus-Erie 24-W drills. Must have casing reel and calf wheel. Give full particulars as to condition and best price. John Herbertson, c/o Box 728, Anchorage, Alaska.

WANTED: Would like to go to South America as a water well driller for a couple of years; or would accept job with a large pump manufacturer as salesman for Texas territory; experienced and good reputation. J. W. Ball, Box 872, Grapevine, Texas, telephone 384-W.



R. S. Postlethwaite of the Water Development Department, Tanganyika, East Africa, and his drilling crew, after completing a 6" well, 287' deep, drilled mostly in granite. Yield was 1700 gallons per hour (28 gpm) and much appreciated in a country of little rainfall where water is scarce.

WANTED: Drillers for all types of wells. T. W. Van Winkle and Son, Salem, Iowa.

FOR SALE: Model L Fort Worth Spudder with tools, mounted on 1942 International truck; Model B International drilling motor; all in good condition, $2000.00. J. W. Ball, Box 872, Grapevine, Texas, telephone 384-W.

FOR SALE: Model 24-W Bucyrus-Erie drilling machine, 1945 model; V-belt drive. Semi-mounted on 7.50 duals, leaf springs with vacuum brakes, $5200.00. Also available: drilling tools, 2-ton, cab-over, 1950 Chevrolet truck; 1100' of ¾" drill line and ⅝" sand line; water tank; chain tongs and numerous hand tools; 200-amp welding machine built into rig. A & B Drilling Company, Box 182, Scobey, Montana.

FOR SALE BY OWNER: One 6 stage Smithway water lubricated deep well turbine, complete with right angle gear drive for 500 g.p.m. 225' total head, 1,760 r.p.m. 70 feet 6" x 1¼" column, 20' suction pipe, prelubricating tank and fittings; pump brand new, never uncrated; price $1,850.00, immediate delivery. Write or wire, Box ABC, 2304 Long Avenue, St. Paul 14, Minnesota.

FOR SALE: Two new Deming 6" stroke deep-well heads, ½ and ¾ H.P. One new Crane deep-well head ¾ H.P. Two used Crane 6" stroke deep-well heads, ½ and ¾ H.P.; one used ¾ H.P. Myers head. All overhauled and guaranteed good as new. One used 1½ H.P. #287 2-stage Berkeley jet pump, single phase motor, overhauled and like new; reasonable. Ray L. Lacey, 4919 London Road, Duluth, Minnesota.

FOR SALE: 1000 ft. 5" new standard pipe with line pipe couplings, $1.40 per ft. Ray L. Lacey, 4919 London Road, Duluth, Minnesota.

FOR SALE: No. 26 Cyclone drilling machine with IXB Hercules power unit, mounted on International truck with 9.00 dual tires. Price $1200, including drilling cable and sand line. George E. Martin & Son, 3103 Martindale Road, Canton 4, Ohio.

WANTED TO BUY: Model 24-L drilling machine. Give condition, equipment, and price first letter. T. W. Van Winkle & Son, Salem, Iowa.

WANTED TO BUY: If priced reasonable, would like to buy medium or large sized water well drill; must be late model in good shape. Bob Tatro, Route 1, Box 96-A, Okmulgee, Oklahoma. Phone 9510FZ.

FOR SALE: Keystone drilling machine, gasoline-powered, mounted on large wooden frame, hard rubber tires; other accessories. Goldbeck Drilling Company, 324 E. Hancock Street, Appleton, Wisconsin.

FOR SALE: Bucyrus-Armstrong drill Model 45W with calf reel, sand line, and 400' new ⅝" drill line; Bucyrus-Erie shock absorber. Mounted on semi-trailer. Price $1,000 with truck; $800 without truck. Claude Kramer, 15925 Loomis Avenue, Harvey, Illinois.

FOR SALE: Well drilling and pump business. One rotary drilling machine, truck mounted. One cable-tool drilling machine. Water truck, pipe truck, pick-up trucks and welding machine. Good warehouse and pipe yard on boulevard frontage, near town. Good stock of pipe, pumps and fittings. An established, sound business with records to show income. Selling on account of illness. Price, $20,000; includes equipment, inventory, property, and trade name. Located in mild climate of southern Georgia. T. R. Davis, 700 Mosley Street, Midalia, Georgia.

WANTED TO BUY: Light-weight, pulling ring and slips for 18" and 20" pipe. Give price, weight and condition first letter. Riegler Water Well Drilling, Inc., 2190 Henry St., Muskegon, Michigan.

FOR SALE: Used Model #40 Cyclone Drill, mounted on truck; also used Model #42 Cyclone Drill. Both in excellent condition and fairly late model machines. Priced to sell. Sanderson Cyclone Drill Company, Orrville, Ohio.

Drilling a 14-inch hole, 325-feet deep as one of a series of wells for the City of Cuttack, India. F. C. Quamber (left) of the Agricultural Engineering workshop is the driller.

(Continued from Page 13)

WANTED: A well-established and experienced drilling company that is interested in taking up water well drilling business in India, with Indian associates, on large government schemes. Contact immediately: Hindustan Industrial Corporation, K40 Connaught Circus, New Delhi 1, India.

FOR SALE: No. 2 Clipper drill; on 5-ton, solid-tired, Biederman truck; 4-cylinder Leroi engine; 32′ mast; new walking beam and temper screw for 2,000′ capacity; complete string of tools, 1⅝ x 2⅝—7 A P I joint; drive clamps; 200′ manila hemp drill line; and 300′ of ⅜″ sand line. Price $1,000. Skinner Bros., Route 5, Chillicothe, Ohio. Phone: 15-109.

FOR SALE: Failing 1,000 Holemaster drilling machine, mounted on 1949 Ford V-8 truck; tools, drill pipe, accessories. Also, 1,500 Holemaster heavy-duty. Fred E. Butler, Box 481, Pueblo, Colorado.

FOR SALE: Bucyrus-Erie Model 21-W drilling machine, A-1 condition, with 1939 Chevrolet truck; 300′ of ⅝″ cable and 400′ of ⅜″ sandline. Machine recently repainted and engine overhauled. Price $2,700. George Brunner, Medford, Wisconsin. Phone: 5482.

FOR SALE: One Ferguson drilling machine, in good shape, eccentric drop-tool; will drill to 600 feet. Price $800. Miss Virginia J. Slaton, Box 163, Bokchito, Oklahoma.

FOR SALE: No. 50 Keystone drill mounted on 3-ton 1942 GMC truck, all A-1 shape; has magneto ignition, starter and generator; calf line, 900′ of ⅝″ drill cable; 900′ of ⅜″ sand line. Harold Adams, Marengo, Iowa.

FOR SALE: Ferguson water-well drill, with eccentric drop tool, in good condition. Machine has capacity to 200 feet. Price $600. Miss Virginia J. Slaton, Box 163, Bokchito, Oklahoma.

FOR SALE: Fishing jars, 4⅞″ bit, combination socket, spear, friction socket and heavy duty elevators. Two 4″ bits and 4″ elevator. Miscellaneous items including sand buckets, jack, tongs, pipe dies, and subs, at about half of new price. Twelve new 12″ B-E shock absorber discs, $35; and 300′ of ¾″ drill line, used on one well, $50. One 5¾″ x 60″ pump cylinder. Ed. Feyh, 3219 Bellefontaine, Kansas City, Missouri.

FOR SALE: Mayhew 1000 drill mounted on 1948 GMC. Failing 1500 drill mounted on 2½-ton GMC. Failing 1000 drill on V-8 truck. Fred E. Butler, Box 481, Pueblo, Colorado.

FOR SALE: Super-D Fort Worth spudder, 3,500-ft. capacity, steel frame, telescoping derrick with Bucyrus shock absorber, casing-reel, cat head. Waukesha power unit mounted on rig. Machine is semi-trailer mounted with 1946 Diamond T tractor. Tools to 18-inch. Also, all-steel custom-built rig mounted on Chevrolet truck, about the size of 22 W; power derrick hoist; Bucyrus shock absorber; V-belt drive to jack shaft. With tools, if desired. Also American Well Works oil-lubricated deep-well turbine pump, 160 gpm. at 360-ft. head; 25 h.p. electric motor; 350 feet column and shaft; complete with all controls. Write: O'Connor & Son, Spring Green, Wisconsin.

ASSOCIATION NEWS

(Continued from Page 13)

This is the twenty-third annual convention of the Nebraska Association.

The Nebraska meeting is one of the most successful and best-attended state drillers' meetings in the country.

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MISSOURI

The 18th annual meeting of the Missouri Water Well Drillers Association will be held April 12 and 13 at the Governor Hotel, Jefferson City. A fine program, along with numerous displays by jobbers, is being planned. Outside space for drilling machines has been arranged. All drillers in Missouri are urged to attend. More information regarding the convention will be reported in the next issue of the Journal.

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ONTARIO

The Ontario Water Well Association will hold its annual meeting and convention in the Oakville Arena, Oakville, on May 13 and 14. In addition to the business meeting of the Association, there will be informative talks, equipment demonstrations and entertainment.

Displays of materials and equipment will be set up by manufacturers and jobbers. This is the first convention of its kind for the water-well industry in Canada. The Association is bending every effort to make it a huge success.

At the last annual meeting the following officers were elected: F. C. Harrison, president, Huntsville, and C. D. McLean, secretary-treasurer, Ottawa.

RECHARGE AND TRAVEL OF POLLUTION

(Continued from Page 7)

clay, or is fringed above or below with such clay, recharging with water having an unfavorable chemical character may cause clogging even though the water is fresh and clear.

Illinois Recharge Investigation

Another very important field test of recharge with river water has been in progress for over two years at Peoria, Illinois.* Water is taken from the Illinois river when the water temperature is below 60°F. and when the turbidity is less than 100 parts per million. The water enters the aquifer through an infiltration pit with a bottom 40 x 62 feet. A bed of filter sand in the pit removes much of the silt and clay in the recharge water. This is a "pilot-plant" installation and experience with it will serve as a basis for designing larger recharge pits.

From October, 1952 to May, 1953 a total of 215 million gallons was fed into the aquifer at Peoria. The average inflow was 1.03 million gallons per day; the maximum in one day at the start of the period was 2.0 million gallons.

At Peoria, turbidity higher than 100 ppm clogs the bed of filter sand rather rapidly, except when the suspended material in the water is largely fine sand rather than clay-like particles .

* Investigation being conducted by the Illinois State Water Survey. Dr. Max Suter is in charge of the project. Infiltration pit, river intake and laboratory were built with state funds and contributions of Peoria industries through the Peoria Association of Commerce.

Air-lift pumping 850 gpm from well drilled in coral sandstone for laundry at Plympton, South Australia. Depth 267 feet, cased to 221 feet. Drilled by Mr. J. J. Priess.

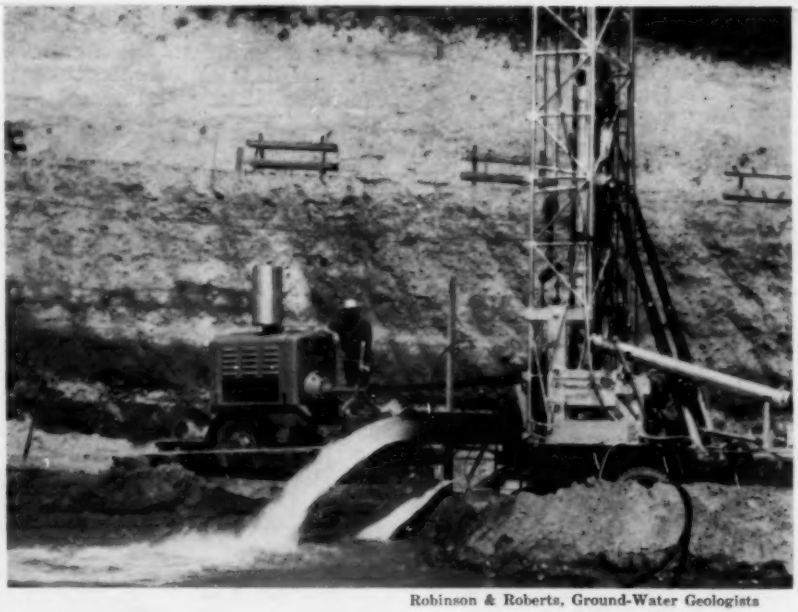
Silas E. Nelsen, Architect — Worthen & Wing, Consulting Engineers

TACOMA, WASHINGTON, DEPARTMENT OF PUBLIC UTILITIES.—The Light Division, directed by Mr. J. Frank Ward, has three high-capacity wells being used for its spanking-new Administration Building. The wells supply water for the unique heat-pump air-conditioning system in this five-story structure. All wells are equipped with Johnson Screens, and were drilled by the L. R. Gaudio Drilling Company of Tacoma.

The picture below shows one of the wells with an 18-inch Everdur well screen, 25 feet long, being tested at a rate of 4.3 million gallons per day, 3,000 gpm, with a drawdown of only 3 feet—a specific capacity of 1000 gpm per foot of drawdown.

All Johnson Screens, for large or small installations, have exactly the same high standards of over-all quality and efficiency. The same features that produced the excellent showing in the picture here are yours, whether for a small farm or home well, or for a large industrial water supply.

Remember, only Johnson Screens have all-welded construction, greatest inlet capacity and non-clogging continuous slots. It pays to buy the very best—and the best works out to be the least expensive in the long run.



Robinson & Roberts, Ground-Water Geologists

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